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The lichen genus *Hypogymnia* in Greenland

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Abstract: Six species of *Hypogymnia* are reported from Greenland. *Hypogymnia incurvoides* is added to the lichen flora of the area. Morphology, chemistry, distribution, habitat and ecology are discussed, and a key to the species is presented. Distribution maps of the species are given.

Kokkuvõte: Hallsamblikud (perekond *Hypogymnia*) Gröönimaal

Vaatluse all on kuus hallsambliku liiki Gröönimaalt. *Hypogymnia incurvoides* on esmasleid sellel alal. Käsitletakse liikide morfoloogiat, keemiat, levikut, kasvukohti ja ökoloogiat; esitatakse liikide määramistabel ja nende levikukaardid.

INTRODUCTION

In total about 50 titles mention *Hypogymnia* in Greenland. Fries (1860), Branth & Grønlund (1888), and Branth (1892) were the first to mention collections of *Hypogymnia* from Greenland, but they only dealt with one taxon, viz. *Hypogymnia physodes*. Lynge & Scholander (1932), Lynge (1937) and Dahl (1950) discussed some nomenclatural, chemical and taxonomic problems, but the concepts of the genus have developed considerably since their work and still are under discussion among taxonomists. Professor Poelt called the attention of the first author to the problem as regards the distinction between arctic populations of *H. austerodes* and *H. subobscura* during a visit in Graz in 1985. Due to much increased collecting in many parts of Greenland during the last fifty years, our knowledge about the distribution of the *Hypogymnia* species is now more complete (Alstrup, 1977, 1982; Alstrup et al., 2000; Gelting, 1955; Hansen, 1978, 1991, 1993, 1995b, 1996, 1997, 1998, 1999, 2002, 2005, 2006, 2008a & b, 2009; K. Hansen, 1962). Only Hansen (1995a) and Thomson (1984) have attempted a total survey of the ecology and distribution of the *Hypogymnia* species in Greenland. Re-examination of Arctic material of *Hypogymnia,* including that from Greenland has shown inconsistent application of species concepts in *H. austerodes*, *H. subobscura*, and *H. bitteri,* as well as numerous examples where odd morphs of *H. physodes* were included in other species. Some important characters differentiating *H. subobscura* from related species have been overlooked. These issues, along with an interest in searching for unrecognized collections of *H. incurvoides*, and a desire to incorporate results from the large number of recent collections in Greenland, motivated us to write this paper. Complementary studies on *Hypogymnia* in Alaska (McCune 2008 and in prep.) are underway.

MATERIAL AND METHODS

Approximately 300 specimens of *Hypogymnia* from Greenland in the herbaria C and O were examined by the authors. Many of them were tested by means of TLC. Unfortunately many of these analyses were relatively primitive and performed 20–30 years ago, before minor satellite compounds such as 2'-*O*-methylphysodic acid were consistently recognized by us. We therefore do not include percentage occurrences of accessory substances. DNA sequences are available for some species, but sampling is still too limited to clarify the difficult species complexes. Specifically the difficult complex of *H. austerodes*, *H. bitteri*, and *H. subobscura* demands a range-wide treatment that supplements morphological with molecular data. All parts of Greenland are represented by the collections. The material is deposited at the Botanical Museums in Copenhagen and Oslo (C & O), respectively.

RESULTS

Key to *Hypogymnia* in Greenland

1a Thallus lacking soredia but laminal or marginal lobules often present

2a Medulla P+ orange-red, containing physodalic acid . . . . . occasional esorediate morphs of *H. physodes*

2b Medulla P-, lacking physodalic acid

3a Lobules laminal and marginal, sparse to abundant; lobes typically slightly separate, becoming imbricate; lobe tips often sparsely perforate . . . . . *H. subobscura*

3b Lobules laminal, usually grading into granular soredia; lobes usually closely contiguous and forming a monolayer, only slightly imbricate; lobe tips lacking holes . . *H. austerodes*

1b Thallus sorediate

4a Soralia becoming lip shaped or hood-shaped, forming inside the burst lobe tips; medulla P+ orange-red

5a Lobes black-margined; lobes arranged to form a semi-regular lattice; lobe tips and axils sparsely to frequently perforate; medulla KC-, lacking 3-hydroxyphysodic acid . . . . . *H. incurvoides*

5b Lobes not usually black margined; lobes in a contiguous in a rosette or somewhat separate, but not forming a lattice; lobe tips and axils imperforate, except where sorediate; medulla KC+ slow reddish brown, containing 3-hydroxyphysodic acid. . . . *H. physodes*

4b Soralia terminal or laminal, but not lip shaped or hood shaped; medulla P-

6a Lobes becoming separated, suberect or erect; branching mainly isotomic dichotomous; upper surface pale mineral gray or pale greenish gray, lobe tips sometimes slightly browned before soredia emerge . . . . . *H. tubulosa*

6b Lobes contiguous, appressed; branching anisotomic in part; upper surface pale greenish gray to more often light to dark brown

7a Soredia diffuse or in irregular laminal soralia, only occasionally terminal and then not on short side lobes; lobe tips imperforate except where damaged . . . . . *H. austerodes*

7b Soralia terminal on the main lobes and/or on the tips of very short side lobes, but laminal soralia also found on many individuals, particularly old ones; lobe tips when esorediate often sparsely perforate with small terminal holes . . . . . *H. bitteri*

The species

Hypogymnia austerodes (Nyl.) Räs.

Thallus appressed, to 5(8) cm broad; branching variable, budding present; lobes contiguous, 0.5–2(2.5) mm wide, sometimes black bordered; lobe tips and axils very rarely perforate; upper surface pale greenish gray to dark brown, often dark mottled, smooth to rugose; soredia almost always present, mainly laminal, developing from subisidiate granules with a deteriorating cortex, sometimes diffuse and powdery on older parts of the thallus; isidia lacking but subspherical granules or lobules often present; medulla hollow; ceiling of cavity white; floor of cavity dark to grayish; lower surface black, imperforate; apothecia not seen in local material; pycnidia rare; spermatia not seen.

Spot tests – Cortex K+ yellow, C-, KC-, P+ pale yellow; medulla K+ slow reddish brown or K-, C-, KC+ orange-red, P-.

Lichen substances – Contains atranorin and physodic acid (major), 3-hydroxyphysodic acid (accessory), 2'-*O*-methylphysodic acid (minor accessory), and an unknown substance with physodic acid.

Discussion – See *H. bitteri* and *H. subobscura*.

Substrate and ecology – On soil, gneissic and basaltic rocks and bark of, for example, *Alnus crispa*, *Betula pubescens* and *Salix glauca*. *H. austerodes* prefers inland areas.

Distribution – *H. austerodes* is more or less common in all parts of West Greenland. The species is occasionally occurring in Central and North East Greenland. It has recently been found at the north coast of Greenland (Fig. 1).

Fig. 1. Distribution of *Hypogymnia austerodes* in Greenland.

Number of specimens examined – 160.
Selected specimens examined – Greenland. Narssarssuaq (61°10´N, 45°26´W), 8 July 1969 J. Andersen & E. S. Hansen 5 (C). Godthåbsfjord, Karra (64°46´N, 50°35´W), Aug 1976 V. Alstrup 766212 (C). Arfersiorfik Fjord, Eqaluarssuit (68°05´N, 51°00´W), 26 Sep 1951 P. Gelting 15836c (C). Christianshåb/Qasigiannguit (68°49´N, 51°10´W), 9 Aug. 1958 K. Hansen 1197 (C). Godhavn (69°15´N, 53°32´W), 11 Sep 1951 P. Gelting (C). Sarqaq (70°01´N, 51°57´W), 29 Oct 1949 P. Gelting (C). Qaanaaq (77°29´N, 69°12´W), 7 July 1986 E. S. Hansen 747 (C). Inglefield Land, area near the head of Rensselaer Bugt (78°35´N, 70°50´W), 23 Aug 1999 E. S. Hansen 1393 (C). Clavering Ø, Theodolit-plateaet (74°22´N, 21°23´W), 29 July 1994 E. S. Hansen 306 (C). Romer Sø (80°59´N, 19°29´W), 26 July 1995 E. S. Hansen 95205 (C). Constable Bugt (83°34´N, 32°01´W), 22 Aug 2007 E. S. Hansen 516 (C).

Hypogymnia bitteri (Lynge) Ahti

Thallus appressed, up to 9(12) cm broad; branching variable, often with lateral budding; lobes contiguous, 0.5-4 mm broad, sometimes black bordered; lobe tips and axils occasionally perforate with a single small hole; upper surface pale greenish gray to brown, often dark mottled, smooth to rugose; soredia almost always present, mainly terminal, both on the main lobes and short, upturned, lateral lobes, sometimes also with extensive diffuse laminal soredia; isidia lacking; lobules sparse or none; medulla hollow; ceiling of cavity white or dark; floor of cavity dark; lower surface black, imperforate; apothecia not seen in local material; pycnidia rare; spermatia not seen.

Spot tests – Cortex K+ yellow, C-, KC-, P+ pale yellow; medulla K- or K+ slow reddish brown, C-, KC+ orange-red, P-.

Lichen substances – Contains atranorin, physodic acid (major), 3-hydroxyphysodic acid (accessory), 2'-*O*-methylphysodic acid (minor accessory), and an unknown substance with physodic acid.

Discussion – The best diagnostic character for *H. bitteri* is the presence of short, narrow, upturned lateral lobes tipped with small soralia. These occur with or without larger terminal soralia or laminal soralia. In contrast, *H. austerodes* typically has only laminal soralia. Occasionally, however, *H. austerodes* has terminal soralia, but usually these are restricted to the larger lobe tips and they are accompanied by extensive laminal soredia.

Substrate and ecology – On mosses, lichens and twigs; also directly on rocks. *H. bitteri* often grows together with *H. austerodes*.

Distribution – *H. bitteri* is occasionally occurring in South West and West Greenland, but rare in North West Greenland. It is mainly an inland species (Fig. 2).

Number of specimens examined – 11.
Selected specimens examined – Greenland. Narssarssuaq (61°10´N, 45°26´W), 8 July 1969 J. Andersen & E. S. Hansen 12 (C). Iterdlaq (60°56´N, 45°16´W), 31 July 1962 K. Hansen 1011 (C). Qingua (61°14´N, 45°31´W), 14 July 1962 K. Hansen 1008 (C). Kapisigdlit (64°26´N, 50°15´W), E. S. Hansen 961 (C). Godhavn (69°15´N, 53°36´W), Jan 1952 P. Gelting 18638 (C).

Hypogymnia incurvoides Rass.

Thallus appressed, up to 10(15) cm broad; branching mostly isotomic dichotomous, budding rare or absent; lobes contiguous to slightly separate, often becoming somewhat imbricate, mostly 1.0–1.5 mm broad; lobe tips and axils

Fig. 2. Distribution of *Hypogymnia bitteri* in Greenland.

sparsely to frequently perforate with holes to about 0.5 mm broad; upper surface whitish to pale greenish gray, usually darkening along the edges, not or somewhat dark mottled, smooth to weakly rugose; lower surface imperforate or nearly so, black except brown at the margins, heavily wrinkled; medulla hollow; ceiling of cavity white to brown, floor of cavity dark gray or dark brown; soredia powdery, terminal from burst lobe tips, initially labriform, then becoming roundish beneath a splayed open lobe tip; isidia and lobules absent; apothecia rare, not seen in local material; ascospores 5.5–6.5×4.8–5.5 µm; mature pycnidia and spermatia not found.

Spot tests – Cortex K+ yellow, C-, KC-, P+ pale yellow; medulla K-, C-, KC+ orange-red, P+ orange-red.

Lichen substances – Consistently contains atranorin, physodic (major), physodalic (major) and protocetraric (minor) acids. The accessory 2'-*O*-methylphysodic acid was detected in 12 of 38 specimens from throughout its range, but not in the specimen from Greenland. Surprisingly, diffractaic acid was detected in the Greenland specimen. While characteristic or a frequent accessory in other *Hypogymnia* species, including *H. diffractaica*, *H. duplicata*, *H. enteromorpha*, *H. hengduanensis*, and *H. imshaugii*, this is the only known occurrence of this substance in *H. incurvoides*.

Discussion – *H. incurvoides* is similar to some forms of *H. physodes*, but is readily distinguished from that species by the presence of holes in the lobe tips and axils, black-margined lobes forming a regular lattice, and the absence of 3-hydroxyphysodic acid. This substance gives a K+ slow reddish brown reaction, which is consistently seen in *H. physodes* but not *H. incurvoides*. Although the soralia are similar in form and position to *H. physodes*, DNA evidence (B. McCune, C. Schoch, and J. Miadlikowska, unpublished) shows that *H. incurvoides* is more closely related to the North American endemic *H. krogiae* than to *H. physodes*. Although perforate, *H. vittata* is easily distinguished from *H. incurvoides* by *H. vittata* having a P- medulla and production of slender perpendicular adventitious perpendicular branches, while *H. incurvoides* has a P+ medulla and lattice of isotomic dichotomous branches without adventitious branching.

Substrate and ecology – On bark of *Betula pubescens*.

Distribution – *H. incurvoides* is known from only one locality in Greenland, where it grows on branches of *Betula pubescens* (Fig. 3). Elsewhere *H. incurvoides* is known from the northen Russia (Arkhangel'sk Region), Sweden, Norway, the coast of eastern Canada (Newfoundland and Nova Scotia; McCune et al. 2006), and the U.S.A. (Maine and the highest peaks of the Appalachian Mountains south to North Carolina; McCune et al. 2007).

Number of specimens examined – 1.
Specimen examined – Greenland. Head of Amitsuarssuk Fjord (60°46 N, 45°14 W), 27 June 1974 K. Holmen (C).

HYPOGYMNIA PHYSODES (L.) Nyl.

Thallus appressed to suberect, to 6(15) cm broad; branching isotomic dichotomous to irregular, budding occasional; lobes contiguous to imbricate or ± separate, 0.5-2.5(4) mm broad; black border not visible from above; lobe tips and axils imperforate or irregularly torn; upper surface white, pale gray to greenish gray, not or rarely dark mottled, smooth to occasionally rugose; medulla hollow; ceiling of cavity white or dark, floor of cavity dark; lower surface black,

Fig. 3. Distribution of *Hypogymnia incurvoides* in Greenland.

rarely perforate; soredia on the inside of the burst lobe tips, developing labriform soralia; isidia absent, lobules rare; apothecia rare, substipitate to stipitate, to 2(4) mm in diam; stipe funnel-shaped, hollow; disc brown; ascospores ellipsoid, 7–8×4.5–5.5 mm; pycnidia occasional; spermatia rod shaped to weakly bifusiform, 5.5–5.8×0.5–0.6 mm.

Spot tests – Cortex K+ yellow, C-, KC-, P+ pale yellow; medulla K+ slow reddish brown, C-, KC+ orange-red, P+ orange-red.

Lichen substances – Contains atranorin, physodic (major), 3-hydroxyphysodic (major), physodalic (major) and protocetraric (minor) acids, with accessory 2'-*O*-methylphysodic acid (minor).

Discussion – Occasional small esorediate individuals can be recognized by the P+ medulla and imperforate lobe tips. See also discussion under *H. incurvoides*.

Substrate and ecology – On soil, mosses and plant remains; also on rocks and bark of, for example, *Betula pubescens*, *Juniperus communis* and *Salix glauca*. The species has a distinct preference for habitats with a thin snow cover during winter, fell-fields at coastal localities and boulders and rocks at inland localities. In wind-exposed areas in South West Greenland *H. physodes* typically grows together with lichens such as *Alectoria ochroleuca*, *A. sarmentosa* ssp. *vexillifera*, *Cetraria muricata*, *Ochrolechia frigida* and *Sphaerophorus globosus* (Hansen 2006). On inland boulders *H. physodes* is often found growing together with *Lobaria scrobiculata* (K. Hansen 1971). On bark the species is associated with *Cetraria sepincola*, *Melanohalea septentrionalis*, *Parmeliopsis ambigua* and *P. hyperopta*.

Distribution – *H. physodes* is widely distributed in South and West Greenland as far north as Inglefield Land. The species is very rare in East Greenland, being known only from Ittoqqortoormiit/Scoresbysund in Central East Greenland (Hansen 1995b). It is a conspicuous lichen and therefore probably not overlooked (Fig. 4).

Fig. 4. Distribution of *Hypogymnia physodes* in Greenland.

Number of specimens examined – 67.

Selected specimens examined – Greenland. Narsarmijit/Frederiksdal (60°00´N, 44°40´W), 28 July 2004 E. S. Hansen LGE 999 (C). Nanortalik (60°09´N, 45°15´W), 5 Feb 1885 P. Eberlin (C). Qagssiarssuk (61°08´N, 45°30´W), 16 July 1937 E. Dahl (C). Narssaq Fjeld (60°57´N, 46°05´W), 21 July 1978 V. Alstrup LGE 258 (C). Ugpik (64°06´N, 51°33´W), 19 July 1990 E. S. Hansen 594a & b (C). Godhavn (69°15´N, 53°32´W), 18 May 1952 P. Gelting 17871 (C.) Inglefield Land,

Hiawatha Camp (78°50´N, 67°18´W), 29 July 1999 990397 (C). Ittoqqortoormiit/Scoresbysund (70°29´N, 21°58´W), 15 July 1987 E. S. Hansen 206 (C).

HYPOGYMNIA SUBOBSCURA (Vain.) Poelt

Thallus appressed, to 10 cm broad; branching variable, budding present; lobes contiguous, 0.5-1.7 mm wide, often black bordered; lobe tips often sparsely perforate with a single small hole; upper surface pale greenish gray to brown, often dark mottled, smooth to weakly rugose; soredia lacking; lobules and subspherical isidia usually present, sparse to dense, laminal or terminal or both; medulla hollow; ceiling of cavity white or darkening; floor of cavity white to dark to grayish; lower surface black, imperforate; apothecia not seen in local material; pycnidia rare; spermatia rod-shaped to weakly bifusiform, 5.0–5.5×0.5–0.8 mm.

Spot tests – cortex K+ yellow, C-, KC-, P+ pale yellow; medulla K-, C-, KC+ orange-red, P-.

Lichen substances – Contains atranorin and physodic acid (major), 2'-*O*-methylphysodic acid (accessory), and an unknown with physodic acid.

Discussion – In its typical form *H. subobscura* is easily distinguished from *H. austerodes* and *H. bitteri* by the absence of soredia, sparse to abundant lobules, and somewhat more open branching. Both *H. austerodes* and *H. bitteri* are more strongly rosette forming, with closely contiguous lobes. Although compact morphs of *H. subobscura* are not uncommon, the more typical form has small spaces between the lobes and a somewhat more imbricate habit. Uncommon forms of *H. austerodes* that lack well-developed soredia and have globose, inflated granules and lobules approach *H. subobscura*. These specimens can usually be separated by one or more of the following: (1) absence of perforations in the lobe tips, (2) presence of 3-hydroxyphysodic acid, or (3) some of the granules with a deteriorating cortex and becoming sorediate. In contrast, *H. subobscura* is often perforate, never has 3-hydroxyphysodic acid, and is never sorediate.

Substrate and ecology – On soil, plant remains, mosses and bark. *H. subobscura* has a distinct preference for inland areas and neutral to alkaline ground, where it occurs together with lichens such as *Cladonia pocillum*, *Flavocetraria nivalis*, *Peltigera rufescens* and *Thamnolia vermicularis*.

Distribution – *H. subobscura* is fairly common in Central West Greenland and North West Greenland and even has been collected at the north coast of Greenland. The species is rare in South West Greenland. It is occasionally occurring in Central and North East Greenland (Fig. 5).

Fig. 5. Distribution of *Hypogymnia subobscura* in Greenland.

Number of specimens examined – 60.

Selected specimens examined – Greenland. Storø (64°32´N, 51°03´W), 24 July 1990 E. S. Hansen 840 (C). Head of Nordfjord (69°56`N, 54°17´W), 10 Aug 1975 V. Alstrup 87 (C). Maarmorilik (71°07´N, 51°17´W), Aug 1983 J. Poelt & H. Ullrich p8-83 (C). Qaanaaq (77°29´N, 69°12´W), 2 July 1986 E. S. Hansen 549 (C). Inglefield Land, Fire Fingre Sø (78°59´N, 67°10´W), 6 Aug 1999 E. S. Hansen 990785 (C). Frigg Fjord, Grønnemark (83°12´N, 34°07´W), 30 June 1995 R. Corner 10 (C). Constable Bugt (83°34´N, 32°01´W), 3 Aug 2007 E. S. Hansen 247 (C). Zackenberg (74°28´N, 20°12´W), 28 July 1994 E. S. Hansen 234 (C).

HYPOGYMNIA TUBULOSA (Schaer.) Hav.

Thallus erect to suberect, to 6(8) cm broad; branching isotomic dichotomous; budding absent or rare; lobes separate to centrally subcontiguous, 1–3(4) mm broad; black border not visible from above; lobe tips and axils imperforate; upper surface white to greenish gray, sometimes dark mottled, becoming rugose; soredia terminal, in capitate soralia, developing from somewhat

brownish swellings on the lobe tips; isidia and lobules absent; medulla hollow; ceiling of cavity white or dark, floor of cavity white or dark; lower surface black, sparsely perforate or imperforate; apothecia rare, not seen in local material; ascospores subglobose, 6–7×5–5.5 mm; pycnidia sparse; spermatia not seen in local material.

Spot tests – Cortex K+ yellow, C-, KC-, P+ pale yellow; medulla K+ slow reddish brown, C-, KC+ orange-red, P-.

Lichen substances – Contains atranorin, physodic acid (major), 3-hydroxyphysodic acid (major), and 2'-*O*-methylphysodic acid (accessory). The single small juvenile thallus from Greenland was not sampled by TLC and therefore the identification is tentative.

Discussion – The species is easily distinguished by its suberect to erect lobes with soredia coating the tips. *H. bitteri* has terminal soralia but an appressed, rosette-like thallus with contiguous lobes and often an overall brownish color.

Substrate and ecology – On wood.

Distribution – The present collection of *H. tubulosa* has probably been introduced via timber used for building of wood constructions on the island Qornoq in Godthåbsfjord (Alstrup 1977) (Fig. 6).

Fig. 6. Distribution of Hypogymnia tubulosa in Greenland.

Number of specimens examined – 1.
Specimen examined – Greenland. Qornoq (64°32´N, 51°06´W), 10 Aug 1976 V. Alstrup 76793 (C).

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